

CLAIMS

What is claimed is:

1. An apparatus (10, 26, 170, 176) for tracking a movable asset (16) and providing tracking information to a monitoring device (22), including:

a tracker tag (12, 12') adapted to selectively receive position data and time data from multiple global positioning system satellites (240) of a global positioning system satellite constellation (24), the position data representing a position of each global positioning system satellite from which data was received with respect to center of Earth (37) and the time data representing a time of day associated with the position data, the tracker tag disposed along an exterior of the movable asset at a location facilitating reception of the position data and time data, the tracker tag combining the position data from the multiple global positioning system satellites for selectively transmitting combined position data and time data via a data communication network (18), wherein the tracker tag is adapted to selectively retrieve a message with command and control information via the data communication network, wherein the tracker tag is inoperative from equipment associated with the asset; and

a tracking information server (14) for command and control of the tracker tag, wherein the tracking information server is adapted to selectively send the message with command and control information to the tracker tag via a messaging system (93), wherein the message is addressed to the tracker tag, wherein the messaging system is accessible to the tracker tag via the data communication network, wherein the tracking information server is adapted to receive the combined position data and time data from the tracker tag via the data communication network, wherein the tracking information server is adapted to selectively receive command and control information from the monitoring device via a tracking information network (20), wherein the tracking information server is adapted to selectively process the combined position data and time data based on programmed instructions and command and control information to produce the tracking information, wherein the tracking information is associated with the asset and selectively accessible to the monitoring device via the tracking information network.

2. The apparatus as set forth in claim 1 wherein the messaging system includes at least one of an e-mail system, a text messaging system, and a paging system.

3. The apparatus as set forth in claim 2, the tracking information server including at least the e-mail system of the messaging system, wherein the e-mail system is associated with the message including the command and control information.

4. The apparatus as set forth in claim 2 wherein the e-mail system is associated with the message including the command and control information and provided by an e-mail service provider independent from the tracking information server.

5. The apparatus as set forth in claim 1, the tracker tag including:

a global positioning system receiver (65) adapted to selectively receive the position data and time data;

a storage device (72) for storing command and control information associated with operation of the tracker tag and for selectively storing the combined position data and time data; and

a processor (70) in communication with the global positioning system receiver and storage device, wherein the processor compares at least one of the position data and time data with predetermined thresholds associated with command and control information stored in the storage device to detect at least one of a group of conditions, the group of conditions including: i) one or more change in state conditions, ii) one or more data acquisition conditions, and iii) one or more data download conditions;

wherein the tracker tag attempts to retrieve a new message from the messaging system upon detection of each change in state condition, wherein the processor stores at least one of the combined position data and time data in the data buffer upon detection of each data acquisition condition, wherein the tracker tag transmits at least one of the combined position data and time data to the tracking information server upon detection of each data download condition.

6. The apparatus as set forth in claim 5 wherein the tracker tag is adapted to selectively send a message to one or more authorized users associated with the monitoring device via the messaging system upon detection of at least one of the one or more change in state conditions, one or more data acquisition conditions, and one or more data download conditions.

7. The apparatus as set forth in claim 6 wherein the messaging system includes at least one of a paging system, an e-mail system, and a text messaging system.

8. The apparatus as set forth in claim 7, the tracking information server including at least the paging system of the messaging system, wherein the paging system is associated with any messages sent to authorized users of the monitoring device upon detection of change in state conditions, data acquisition conditions, and data download conditions.

9. The apparatus as set forth in claim 7 wherein the paging system is associated with the any message sent to authorized users of the monitoring device upon detection of change in state conditions, data acquisition conditions, and data download conditions and provided by a paging service provider independent from the tracking information server.

10. The apparatus as set forth in claim 1, the tracker tag including:

a global positioning system receiver (65) adapted to selectively receive the position data and time data;

a storage device (72) for storing command and control information associated with operation of the tracker tag and for selectively storing the combined position data and time data;

a network processor (63) adapted to selectively retrieve new messages with command and control information from the messaging system and selectively transmit the combined position data and time data to the tracking information server; and

a sensor processor (71) in communication with the global positioning system receiver, and storage device, and network processor, wherein the sensor processor compares at least one of the position data and time data with predetermined thresholds associated with command and control information stored in the storage device to detect at least one of a group of conditions, the group of conditions including: i) one or more change in state conditions, ii) one or more data acquisition conditions, and iii) one or more data download conditions;

wherein the sensor processor initiates retrieval a new message from the messaging system by the network processor upon detection of each change in state condition, wherein the sensor processor stores at least one of the combined position data and time data in the data buffer upon detection of each data acquisition condition, wherein the sensor processor initiates transmission of at least one of the combined position data and time data to the tracking information server by the network processor upon detection of each data download condition.

11. The apparatus as set forth in claim 10, the tracker tag further including:

an asset communication interface (75) in communication with the sensor processor to provide a communication path between the sensor processor and at least one of the asset and a transport vehicle associated with the asset.

12. The apparatus as set forth in claim 11 wherein the asset communication interface is adapted to selectively receive sensor information from one or more of at least one asset sensor and at least one transport vehicle sensor, and at least one operational sensor associated with the

transport vehicle, wherein the sensor processor compares the sensor information with corresponding predetermined thresholds associated with command and control information stored in the storage device to detect at least one of the one or more change in state conditions, one or more data acquisition conditions, and one or more data download conditions.

13. The apparatus as set forth in claim 12 wherein the asset communication interface is adapted to selectively transmit command and control information to one or more of at least one asset control device and at least one transport vehicle control device, wherein the sensor processor also compares at least one of the position data, time data, and sensor information with predetermined thresholds associated with command and control information stored in the storage device to detect one or more asset/transport vehicle control conditions, wherein the sensor processor transmits asset/transport vehicle control information to the one or more of at least one asset control device and at least one transport vehicle upon detection of each asset/transport vehicle control condition to control one or more aspect of operation of at least one of the asset and transport vehicle.

14. The apparatus as set forth in claim 11 wherein the asset communication interface is adapted to selectively transmit command and control information to one or more of at least one asset control device and at least one transport vehicle control device, wherein the sensor processor also compares at least one of the position data and time data with predetermined thresholds associated with command and control information stored in the storage device to detect one or more asset/transport vehicle control conditions, wherein the sensor processor transmits asset/transport vehicle control information to the one or more of at least one asset control device and at least one transport vehicle upon detection of each asset/transport vehicle control condition to control one or more aspect of operation of at least one of the asset and transport vehicle.

15. The apparatus as set forth in claim 1, the tracker tag including:

- a global positioning system receiver (65) adapted to selectively receive the position data and time data;

- an environmental sensor (66) for sensing an environmental condition;

- a storage device (72) for storing command and control information associated with operation of the tracker tag and for selectively storing the combined position data, time data, and sensor data associated with the environmental sensor; and

- a processor (70) in communication with the global positioning system receiver,

environmental sensor, and storage device, wherein the processor compares measurements from the environmental sensor with predetermined thresholds associated with command and control information stored in the storage device to detect at least one of a group of conditions, the group of conditions including: i) one or more change in state conditions, ii) one or more data acquisition conditions, and iii) one or more data download conditions;

wherein the tracker tag attempts to retrieve a new message from the messaging system upon detection of each change in state condition, wherein the processor stores at least one of the combined position data, time data, and sensor data in the data buffer upon detection of each data acquisition condition, wherein the tracker tag transmits at least one of the combined position data, time data, and sensor data to the tracking information server upon detection of each data download condition.

16. The apparatus as set forth in claim 15, wherein the environmental sensor includes at least one of a vibration sensor, a temperature sensor, a strain gauge, a voltage sensor, a pressure sensor, and an electric field sensor.

17. The apparatus as set forth in claim 1, the tracker tag including:

a global positioning system receiver (65) adapted to selectively receive the position data and time data;

an environmental sensor (66) for sensing an environmental condition;

a storage device (72) for storing command and control information associated with operation of the tracker tag and for selectively storing the combined position data, time data, and sensor data associated with the environmental sensor;

a network processor (63) adapted to selectively retrieve new messages with command and control information from the messaging system and selectively transmit the combined position data and time data to the tracking information server; and

a sensor processor (71) in communication with the global positioning system receiver, and storage device, and network processor, wherein the processor compares measurements from the environmental sensor with predetermined thresholds associated with command and control information stored in the storage device to detect at least one of a group of conditions, the group of conditions including: i) one or more change in state conditions, ii) one or more data acquisition conditions, and iii) one or more data download conditions;

wherein the sensor processor initiates retrieval a new message from the messaging system by the network processor upon detection of each change in state condition, wherein the sensor processor stores at least one of the combined position data and time data in the data buffer upon

detection of each data acquisition condition, wherein the sensor processor initiates transmission of at least one of the combined position data and time data to the tracking information server by the network processor upon detection of each data download condition.

18. The apparatus as set forth in claim 17, wherein the environmental sensor includes at least one of a vibration sensor, a temperature sensor, a strain gauge, a voltage sensor, a pressure sensor, and an electric field sensor.

19. A tracking system (10, 26, 170, 176), including:

- a monitoring device (22) for displaying tracking information associated with a movable asset (16);

- a tracking information network (20) in communication with the monitoring device for communicating the tracking information to the monitoring device;

- a data communication network (18);

- a tracker tag (12, 12') adapted to selectively receive position data and time data from multiple global positioning system satellites (240) of a global positioning system satellite constellation (24), the position data representing a position of each global positioning system satellite from which data was received with respect to center of Earth (37) and the time data representing a time of day associated with the position data, the tracker tag disposed along an exterior of the movable asset at a location facilitating reception of the position data and time data, the tracker tag combining the position data and time data from the multiple global positioning system satellites for selectively transmitting combined position data and time data via the data communication network, wherein the tracker tag selectively retrieves command and control information via the data communication network; and

- a tracking information server (14) for command and control of the tracker tag, wherein the tracking information server selectively sends command and control information to the tracker tag via a messaging system (93), wherein the message is addressed to the tracker tag, wherein the messaging system is accessible to the tracker tag via the data communication network, wherein the tracking information server receives combined position data and time data from the tracker tag via the data communication network, wherein the tracking information server selectively receives command and control information from the monitoring device via the tracking information network, wherein the tracking information server selectively processes the combined position data and time data to produce the tracking information, wherein the tracking information is selectively accessible to the monitoring device via the tracking information network.

20. The apparatus as set forth in claim 1 wherein the messaging system includes an e-mail system.
21. The apparatus as set forth in claim 20, wherein the e-mail system is associated with the message including the command and control information.
22. The apparatus as set forth in claim 21 wherein the e-mail system is provided by an e-mail service provider independent from the tracking information server.
23. A method for monitoring sensor data associated with a moveable asset using a tracker tag in communication with a tracking information server, including the steps:
- a) attaching a tracker tag to the moveable asset, wherein the tracker tag is disposed along an exterior of the movable asset at a location in which the tracker tag has line of sight access to the sky during normal movement of the asset, wherein the tracker tag is inoperative from equipment associated with the asset, wherein the tracker tag includes an installed tag profile that includes programmed instructions to control current operation of the tracker tag, wherein the tracking information server includes a master tag profile that is re-configurable and at least initially the same as the installed tag profile;
 - b) re-configuring the master tag profile at the tracking information server to create a next tag profile, wherein the next tag profile includes programmed instructions to control subsequent operation of the tracker tag;
 - c) selectively sending the next tag profile to the tracker tag in a message via a messaging system, wherein the messaging system is accessible to the tracker tag via a data communication network;
 - d) powering up the tracker tag;
 - e) detecting a change in state condition with the tracker tag and responding to the change in state condition in accordance with the programmed instructions in the installed tag profile, wherein the response to the change in state condition includes retrieving the message with the next tag profile from the messaging system and installing the next tag profile in the tracker tag, wherein, upon installation, the next tag profile becomes the installed tag profile for control of current operations of the tracker tag;
 - f) detecting a data acquisition condition with the tracker tag and responding to the data acquisition condition in accordance with the programmed instructions in the installed tag profile, wherein the response to the data acquisition condition includes acquiring and storing sensor data associated with at least one sensor of one or more sensors associated with the tracker tag, one or

more sensors associated with the asset, and one or more sensors associated with a transport vehicle associated with the asset; and

g) detecting a data download condition with the tracker tag and responding to the data download condition in accordance with the programmed instructions in the installed tag profile, wherein the response to the data download condition includes downloading the stored sensor data to the tracking information server via the data communication network, wherein the tracking information server processes the downloaded sensor data to create sensor information and displays the sensor information on a monitoring device via a tracking information network.

24. The method as set forth in claim 23 wherein the messaging system is an e-mail system.

25. The method as set forth in claim 24 wherein the e-mail system is included within the tracking information server.

26. The method as set forth in claim 24 wherein the e-mail system is provided by an e-mail service provider independent from the tracking information server.

27. The method as set forth in claim 23 wherein the tracker tag includes a processor in communication with the at least one sensor, wherein the processor compares measurements from the each sensor of the at least one sensor with predetermined thresholds within the programmed instructions in the installed tag profile to detect each change in state, data acquisition, and data download condition.

28. The method as set forth in claim 23, step b) further including the following steps:

h) receiving a selection from a user of the monitoring device to re-configure the master tag profile;

i) if the user is authorized to re-configure the master tag profile, providing the user with a configure tag profile display to re-configure the master tag profile;

j) receiving one or more selections from the user in conjunction with one or more desired change in state conditions, one or more desired data acquisition conditions, and one or more desired data download conditions associated with subsequent operation of the tracker tag;

k) updating the programmed instructions in the master tag profile based on the desired change in state, data acquisition, and data download conditions to create the next tag profile; and

l) generating the message with the next tag profile to be sent to the messaging system.

29. The method as set forth in claim 23, step d) further including the following steps:
- h) performing a self-test of the tracker tag; and
 - i) determining if the self-test passed or failed, wherein the programmed instructions in the installed tag profile identify change in state conditions for passing self-test and for failing self-test.
30. The method as set forth in claim 23, step e) further including the following steps:
- h) waking up a sensor processor in the tracker tag, wherein the sensor processor detected the change in state condition based on detecting at least one parameter identified as a change in state condition in the programmed instructions associated with the installed tag profile;
 - i) starting up a network processor in the tracker tag;
 - j) initiating a communication between the network processor and the messaging system;
 - k) after communication between the network processor and the messaging system is confirmed, checking for a new message to the tracker tag and, if a new message is found, uploading the next tag profile associated with the new message to the network processor;
 - l) terminating the communication between the network processor and the messaging system;
 - m) passing the next tag profile from the network processor to the sensor processor and shutting down the network processor;
 - n) if a new message was found in step k), installing the next tag profile in a storage device associated with the sensor processor, wherein, upon installation, the programmed instructions of the next tag profile previously associated with subsequent operation of the tracker tag transition to programmed instructions in the installed tag profile for control of current operations of the tracker tag; and
 - o) placing the sensor processing in a sleep state.
31. The method as set forth in claim 23, step f) further including the following steps:
- h) waking up a sensor processor in the tracker tag, wherein the sensor processor detected the data acquisition condition based on detecting at least one parameter identified as a data acquisition condition in the programmed instructions associated with the installed tag profile;
 - i) acquiring and storing sensor data associated with at least one sensor of the tracker tag, asset, and transport vehicle in accordance with the programmed instructions in the installed tracker tag; and
 - j) placing the sensor processing in a sleep state.

32. The method as set forth in claim 23, step g) further including the following steps:

h) waking up a sensor processor in the tracker tag, wherein the sensor processor detected the data download condition based on detecting at least one parameter identified as a data download condition in the programmed instructions associated with the installed tag profile;

i) starting up a network processor in the tracker tag;

j) initiating a communication between the network processor and the tracking information server;

k) after communication between the network processor and the tracking information server is confirmed, downloading the stored sensor data from a storage device associated with the sensor processor through the network processor to the tracking information server via the data communication network;

l) terminating the communication between the network processor and the tracking information server;

m) shutting down the network processor; and

n) placing the sensor processing in a sleep state.

33. The method as set forth in claim 32, between steps j) and k) further including the following step:

o) after communication between the network processor and the tracking information server is confirmed, sending a page to a paging system addressed to one or more users associated with the monitoring device in accordance with the programmed instructions in the installed tag profile.

34. The method as set forth in claim 33 wherein the paging system is included within the tracking information server.

35. The method as set forth in claim 33 wherein the paging system is provided by a paging service provider independent from the tracking information server.

36. A method for tracking a moveable asset using a tracker tag in communication with a tracking information server, including the steps:

a) attaching a tracker tag to the moveable asset, wherein the tracker tag is disposed along an exterior of the movable asset at a location in which the tracker tag has line of sight access to the sky during normal movement of the asset, wherein the tracker tag is inoperative from equipment associated with the asset, wherein the tracker tag includes an installed tag profile that

includes programmed instructions to control current operation of the tracker tag, wherein the tracking information server includes a master tag profile that is re-configurable and at least initially the same as the installed tag profile;

b) re-configuring the master tag profile at the tracking information server to create a next tag profile, wherein the next tag profile includes programmed instructions to control subsequent operation of the tracker tag;

c) selectively sending the next tag profile to the tracker tag in a message via a messaging system, wherein the messaging system is accessible to the tracker tag via a data communication network;

d) powering up the tracker tag;

e) detecting a change in state condition with the tracker tag and responding to the change in state condition in accordance with the programmed instructions in the installed tag profile, wherein the response to the change in state condition includes retrieving the message with the next tag profile from the messaging system and installing the next tag profile in the tracker tag, wherein, upon installation, the next tag profile becomes the installed tag profile for control of current operations of the tracker tag;

f) detecting a data acquisition condition with the tracker tag and responding to the data acquisition condition in accordance with the programmed instructions in the installed tag profile, wherein the response to the data acquisition condition includes acquiring and storing position data and time data associated with a global positioning system receiver in the tracker tag; and

g) detecting a data download condition with the tracker tag and responding to the data download condition in accordance with the programmed instructions in the installed tag profile, wherein the response to the data download condition includes downloading the stored position data and time data to the tracking information server via the data communication network, wherein the tracking information server processes the downloaded position data and time data to create tracking information and displays the tracking information on a monitoring device via a tracking information network.

37. The method as set forth in claim 36 wherein the tracker tag includes a processor in communication with the global positioning system receiver, wherein the processor compares at least one of the position data and time data with predetermined thresholds within the programmed instructions in the installed tag profile to detect each change in state, data acquisition, and data download condition.

38. The method as set forth in claim 36, step e) further including the following steps:

h) waking up a sensor processor in the tracker tag, wherein the sensor processor detected the change in state condition based on detecting at least one parameter identified as a change in state condition in the programmed instructions associated with the installed tag profile;

i) starting up a network processor in the tracker tag;

j) initiating a communication between the network processor and the messaging system;

k) after communication between the network processor and the messaging system is confirmed, checking for a new message to the tracker tag and, if a new message is found, uploading the next tag profile associated with the new message to the network processor;

l) terminating the communication between the network processor and the messaging system;

m) passing the next tag profile from the network processor to the sensor processor and shutting down the network processor;

n) if a new message was found in step k), installing the next tag profile in a storage device associated with the sensor processor, wherein, upon installation, the programmed instructions of the next tag profile previously associated with subsequent operation of the tracker tag transition to programmed instructions in the installed tag profile for control of current operations of the tracker tag; and

o) placing the sensor processing in a sleep state.

39. The method as set forth in claim 36, step f) further including the following steps:

h) waking up a sensor processor in the tracker tag, wherein the sensor processor detected the data acquisition condition based on detecting at least one parameter identified as a data acquisition condition in the programmed instructions associated with the installed tag profile;

i) acquiring and storing the position data and time data in accordance with the programmed instructions in the installed tracker tag; and

j) placing the sensor processing in a sleep state.

40. The method as set forth in claim 36, step g) further including the following steps:

h) waking up a sensor processor in the tracker tag, wherein the sensor processor detected the data download condition based on detecting at least one parameter identified as a data download condition in the programmed instructions associated with the installed tag profile;

i) starting up a network processor in the tracker tag;

j) initiating a communication between the network processor and the tracking information server;

k) after communication between the network processor and the tracking information

server is confirmed, downloading the stored position data and time data from a storage device associated with the sensor processor through the network processor to the tracking information server via the data communication network;

l) terminating the communication between the network processor and the tracking information server;

m) shutting down the network processor; and

n) placing the sensor processing in a sleep state.